Industry Update

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Pioneer…a DuPont Company

Background:
- Who am I and what do I do?
  - Crop and Soil Specialist
  - Educator
  - Researcher
Industry Update…

- Pioneer Hi-Bred
  - plant genetics company
  - Subsidiary of DuPont
  - Representative of the field crops seed industry
    - Worked with Genetically enhanced (GE) crops for 12 years.
    - I don't have all the answers

Industry Update…Topics

- Biotechnology – or “Genetically Enhanced” (GE) crops (Genetically Modified Organisms, GMOs)
  - Insect Resistance
  - Herbicide Resistance
- What’s coming down the road…
- “Non-food” usage of traditional crops ~ corn
Kraft CEO Roger Deromedi, speaking at the Reuters Food Summit in Chicago, stated: “that over time genetically modified ingredients will play a very important role both nutritionally and environmentally in terms of reduction of pesticide use around the world.”

One of the world's most difficult challenges...

We believe the tools of biotechnology can help generate more affordable, efficient and environmentally sustainable solutions.

- Chemicals
- Nutrients
Biotech Critics

The introduction of transgenic plants has not been without controversy. Several organizations continue to fight against GE products.

Summary

- Genetic engineering is a crude and old fashioned technology.
- GE relies on the outdated Central Dogma of molecular biology which is 50 years old.
- GE disregards all the new knowledge on gene regulation.
- GE is not compatible with the complex regulatory systems that control gene expression.
- GE commonly gives rise to unexpected effects, with unknown implications to the environment or food safety.

THE GE INDUSTRY ARE LIVING ON A FLAT EARTH!

GREENPEACE
Biotech Critics

 Critics claim GE crops:
 – Are not safe to eat
 – They do not perform well
 – Natural resistance will soon arise
 – Genes will escape and thereby contaminate other crops or produce “superweeds”

GE mishaps
 – Unapproved GE corn found in food
   • 2000 corn crop (Starlink – approved for feed)
 – Imported seed for planting...contaminated with GE seed (EU, 1999)
   • “USDA did not follow procedural requirements”
     – Prepare an environmental impact statement in place of environmental assessment that was completed
DuPont/Pioneer’s Philosophy

• GE crops must not be lumped together into a single class of so-called genetically modified organisms.
• As new and unique products are developed, each must be judged on its own merits and the value it delivers.

DuPont/Pioneer’s Philosophy

• No technology should be employed simply because it is possible.
• Regulation of these new products is supported by Pioneer
• Pioneer meets or exceeds all the requirements placed on the introduction of these products worldwide.
Biotechnology…getting it to the marketplace…safely

What does it take to get a genetically enhanced product to the market place?

Biotechnology…The Process

Trait Discovery → Product Development → Commercialization

Product Concept → Gene Discovery → Transformation → GH & Field Evaluation → Line Selection → Variety Development → Field Production → Market → Point of Market

Early safety evaluation

USDA
EPA
FDA

Product stewardship
Biotech product safety falls under three federal agencies:
- USDA: Environmental safety
- EPA: Environmental, food and feed safety for pest-protected product registration and sales
- FDA: Feed and food safety

Public participation is solicited by these agencies at several steps in the process.
Safety of genes

- Is the genetic component/donor organism a pathogen?
- Does it produce a known toxicant, allergen, or irritant?
- Is there a history of safe use of the source organism?

Safety of proteins...

After gene insertion:
- Indicate if there are changes in the amino acid sequence from the native protein.
- Submit data indicating if the protein is expressed as expected.
- Compare novel protein sequence to known toxins and allergens.
- Acute/Chronic testing, in mice/rats.
Safety of proteins...

- The protein is compared to proteins in large global databases.
  - More than 100,000 different proteins are searched.
- A “Macro” comparison looks at the whole protein.
- A “Micro” comparison looks at small stretches of the protein.
  - As few as 8 amino acids are compared
  - For the Cry proteins, more than 600 searches are performed across the entire protein length

A new biotech plant...is it safe?

- Lab tests show they are compositionally equivalent.
- Feeding trials have shown them to be nutritional equivalent.
- Feeding trials have shown: no detections of biotech genes in:
  - Milk
  - Meat
  - Eggs
Biotech Safety...  
10 years and counting

- Biotech crops arrived in the market in the mid 1990s
- “There hasn't been a single documented case of an illness caused by an FDA approved food developed with biotechnology.”
  
  Aaron, David, former undersecretary of Commerce and Trade

A report from the European Commission concluded:

- “the use of more precise technology and the greater regulatory scrutiny [over biotech foods] probably make them even safer than conventional plants and foods.”

Commission Launches Roundtable on GMO Safety Research,” European Commission, Sept. 10, 2001
Biotechnology ~
Who is using GM Crops?

- Is it just for the developing countries?
- Who can afford the extra seed cost?

Biotechnology... global usage

- Since 1995
  - 8.5 million farmers have grown GM crops
    - >7 million are small-farmers in developing countries
  - They have been grown on more than 1 billion acres
  - In 17 countries
Success story ~ Chinese GM Cotton
- Most pesticide-intensive major crop
- GM cotton first planted in 1998
- 2005: 50% of acreage
- Yields have increased 10-30%
- Pesticide usage has fallen 50-80%
Success story ~ Chinese GM Cotton
- Profitability for small farmers has improved significantly
  - In 01-02 it was difference between profit and loss
- Pesticide poisonings from insecticides have decreased by ~ 75% for those using GM cotton
  - Before 1996 ~ 10,000 insecticide poisoning and ~ 400 deaths occurred annually

US and GM cotton...most complete study to date, Univ. of Arizona, BIO5 Institute

2006 Research in an the Proceedings of the National Academy of Science:
"Biotech Cotton: 8 Bugs: 0"
- "We found no net increase in insect resistance to Bt. If anything, resistance decreased. This is the opposite of what experts predicted when these crops were first commercialized." He added, "I'm definitely surprised."

Bruce E. Tabashnik, expert in insect resistance to insecticides
Biotech…an example…Bt Corn

Biotechnology in the Michigan marketplace

Insect resistant corn

- Gene source: Bacillus thuringiensis (Bt) - soil bacteria
- Introduction: 1996
- Benefits:
  - Pinpoint accuracy
  - No effect on beneficial insects
Conventional Corn

Genetically Modified Corn
Biotech...an example...Bt corn

**VALUE OF BT HYBRIDS**

- ~ 12 bu/A @ $3.00 bu = $36.00/acre - $6.00 Bt Seed
- Across 100 acres = $3000 advantage

<table>
<thead>
<tr>
<th>Location</th>
<th>Bushels/acre</th>
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<tr>
<td>LOC 1</td>
<td>46 bu</td>
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<tr>
<td>LOC 2</td>
<td>14 bu</td>
</tr>
<tr>
<td>LOC 3</td>
<td>2 bu</td>
</tr>
<tr>
<td>LOC 4</td>
<td>10 bu</td>
</tr>
</tbody>
</table>

Biotechnology in the Michigan marketplace

- Insect resistant corn – Bt - 1
  - Target insects: European Cornborer, Black Cutworm
Biotechnology in the Michigan marketplace

Insect resistant corn – Bt-2 – Target insects: Corn Rootworm larvae

Biotech ~ Re-registration

- EPA re-registered Bt Corn (Oct. 2001)
- Pronounced “Safe” to the environment
The Monarch Butterfly is not threatened?

Monarch Butterfly

- Lab studies showed Bt pollen can kill larvae
- Field settings - Pollen from Bt corn, showed no affect on monarch pop'n
- Human activity – results in significant pop'l'n loss.
- Iowa State University - reports that 26% of farmers who planted corn with Bt reduced insecticide use; 54% said they used no insecticide
- Less chemical means - cleaner water, healthier soils,

Usage of Biotech Bt Corn by Pioneer customers in Michigan – 2006-2007
Biotechnology - Stewardship

Grower Agreements for some Biotech crops...

**Bt hybrid agreement**
- Requires a 20% refuge of non-Bt corn
- Signed by farmers before planting
  - Sales agent commission withheld
- EPA monitors compliance.
  - Non compliance will mean technology withdrawn from Market

**Biotechnology Stewardship**

- Romania
- New Environmental Protection Law
- Romania issued a new law on environmental protection in December 2005, which contains a section on biotech cultivation enforcing certain conditions of the existing Romanian biotech law, such as the restrictions of biotech cultivation near Natural Protected Areas. According to this new section, farmers face severe penalties if they do not notify the Ministry of Environment of their plans to cultivate genetically modified organisms, and if they do not sign a contract with the seed companies, in which they agree to comply with stewardship conditions.
- Pioneer sales representatives are in touch with customers to inform them of this new law. To ensure compliance, each farmer will have to sign a Pioneer “Sales and Purchase Agreement.”
Biotechnology in the Michigan marketplace

Herbicide resistant crops
- Roundup Ready resistance
  - Gene source: soil bacteria
  - Introduction ~ 1996
- Liberty Link crops


- **2003 Acres**
  - Roundup: 82%
  - Conventional: 18%

- **2005 Acres**
  - Roundup: 95%
  - Conventional: 5%

- **2007 Acres**
  - Roundup: 96%
  - Conventional: 4%
Five weed management systems, ranging from total reliance on glyphosate to no glyphosate, were evaluated over a four-year period in a soybean-corn rotation in chisel and no-tillage systems.

- All systems provided high levels of weed control
- The glyphosate-only system did allow nearly a 66% reduction in the total amount of herbicide active ingredient applied compared with the system relying on conventional preemergence and postemergence herbicides.
Biotechnology – a bug in the system…its too good.

Regulated vs Unregulated technology –
- Bt = Regulated
- RR = Un-regulated

Roundup (glyphosate)
Resistant weeds:
- Horseweed
- Lambsquarter
- Ragweed

Biotech – Roundup Ready Crops

- Crops with RR gene:
  - Soybeans
  - Corn
  - Cotton
  - Canola
  - Sugarbeets

- Crops on the list to receive the RR gene:
  - Wheat
  - Rice
Pioneer will release a new herbicide resistant trait
- GAT – glyphosate/ALS Tolerance
- No yield drag with this gene

Biotechnology…for the consumer

High Oleic soybean oil…2009
- Healthier soybean oil
- No trans fats
- Improved flavor
- Improved digestibility
Biotechnology – What’s on the horizon...2012?

Agronomic
- Drought/heat tolerance
- Improved disease resistance

Drought Tolerant Corn

Key features:
- Increase yield
- Reduce risk
- Lower irrigation cost & availability
Biotechnology – What’s on the horizon...2010?

- Nutritional
  - Available energy
  - Lysine/Methionine
  - Reduced mycotoxins

Biotechnology – What’s on the horizon “Pharm” crops...2012?

- Vaccines produced from plants are safer than those developed in eggs or other animal hosts.

- A plant-based vaccine system will reduce the risk of contamination by animal pathogens.
Biotech…new developments

- WTO ruling on EU
- Local Seed laws

Biotech – WTO ruling

- WTO Interim Report Issued in favor of the U.S., Canada & Argentina
- The World Trade Organization (WTO) ruled February 7th on the European biotech crop moratorium.
- WTO ruled in favor of the U.S., Canada and Argentina stating that the EU moratorium violates international trade rules.
- This is a significant ruling in favor of biotechnology.
The Latest in Ethanol Research…
University of Cal. Berkeley

Feb. 1, 2006,
“Putting ethanol instead of gasoline in your tank
saves oil and is probably no worse for the environment than burning gasoline.”
The Latest in Ethanol Research…
University of Cal. Berkeley

The researchers note…“new technologies now in development promise to make ethanol a truly "green" fuel with significantly less environmental impact than gasoline.”

Area Ethanol Plants

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Size</th>
<th>Status</th>
</tr>
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<tbody>
<tr>
<td>Michigan Ethanol</td>
<td>Caro</td>
<td>63 million gal.</td>
<td>On line</td>
</tr>
<tr>
<td>Great Lakes Ethanol</td>
<td>Riga</td>
<td>63 million gal.</td>
<td>In DEQ Permitting</td>
</tr>
<tr>
<td>Superior Corn Products</td>
<td>Lake Odessa</td>
<td>53 million gal.</td>
<td>Under Construction</td>
</tr>
<tr>
<td>Andersons, Inc.</td>
<td>Albion</td>
<td>50 million gal.</td>
<td>Under Construction</td>
</tr>
<tr>
<td>Marysville Ethanol</td>
<td>Marysville</td>
<td>50 million gal.</td>
<td>In DEQ Permitting</td>
</tr>
<tr>
<td>Suncor</td>
<td>Sarnia, Ont.</td>
<td>52 million gal.</td>
<td>Complete Mid 2006</td>
</tr>
</tbody>
</table>

Total area Ethanol = 331mmg/y  
Note: the U.S. uses 140 billion gallons of gasoline annually.
Non-food use of traditional food crops ~ Corn

Huge new market!!

Corn for ethanol production will utilize ~40% of the Michigan Corn crop in 2006-2007.
Bio-fuel facilities in Michigan

MASCOMA IS A NAME THAT WILL BECOME VERY FAMILIAR TO MICHIGAN RESIDENTS, ESPECIALLY THOSE IN THE NORTHERN LOWER PENINSULA OVER THE NEXT FEW WEEKS AND MONTHS. Thursday morning, along with the Governor and others, they announced their intentions to build a wood based, bio-mass ethanol production facility in the state, and marry their technology and those of Michigan State University and Michigan Tech to become the first commercial, solely bio-based ethanol plant in the U.S. Their technology produces roughly 80 gallons of fuel for every 2.5 tons of wood. Mascoma also announced their intention to ultimately use plant based biomass, whether from switchgrass, corn stalks or other material, and work with their partner Universities to develop genotypes of plants that fit the ethanol production process. While the specific site of the new plant is yet to be finalized, it certainly will be near their feedstock…wood! This announcement clearly puts Michigan on the map in the quest to become the center of the renewable fuel industry in the U.S.

Food or Fuel...

If corn prices are sustained in the $3.50-4.00 per bushel range...

Consumers could experience a minor increase in retail prices for some grocery items.

At the Agriculture Outlook Forum in March 2007, USDA presented a forecast of a 2 to 3 percent increase in the food prices for 2007.

- This range would be in line with the 25-year average for year-on-year food price percentage increases.
Food or Fuel...

U.S. Corn Yield History and Trend

35-year trend  15-year trend  10-year trend
Non-food use of traditional food crops ~ Corn

- PLA – polylactic acid
  - Clothing
  - Biodegradable containers

Heating Bill Comparison

- Propane
- Electricity
- Biodiesel
- Cordwood
- Soybean oil
- Wood pellets
- Heating oil
- Natural gas
- Yellow grease
- Wood chips
- Corn
Non-food use of traditional food crops ~ Corn

- **Corn for heating**
  - Several Michigan prisons may be heated with corn/bio based fuels

- **Biodiesel from:**
  - Soybeans
  - Yellow grease
  - Brown grease
- Responsible for driving value-creation opportunities in bio-fuels, bio-medical and bio-surfaces applications.

DuPont Bio-Based Materials – Sorona® and Bio-PDO™.
- Responsible for globalizing adoption of DuPont™ Sorona® and Bio-PDO™, the first DuPont materials made using corn as the raw material.

Questions??

“"We have large and various orchards and gardens wherein we practice all conclusions of grafting and inoculation, whereby we make trees and flowers to come earlier or later than their seasons, and their fruit greater and sweeter and of differing taste, smell, colour, and figure from their nature; and likewise to make one tree or plant turn into another."

The English philosopher Sir Francis Bacon predicting the future of agricultural research in 1618 (extract from New Atlantis).